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IV TECHNIQUES OF SURVEY

THE BRITISH RAIL LAND SURVEY

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ABSTRACT

A multivariate geographic classification was prepared and used to structure an ecological survey of British Rail land. Existing land classifications refer to cellular units and could not be adapted to this study because there is no constant relationship between the length of railway line crossing a cell and the area of land within that cell.

INTRODUCTION

The British Rail (BR) Land Survey has developed in response to concern about structural and qualitative changes in railway vegetation. These result from a radical post-war reduction and alteration in verge and cess (track bed) management practices. The purpose of the Survey is to provide baseline information by recording, classifying and mapping the distribution of vegetation types and species. The information will be used to measure further change and is fundamental to management and conservation decisions.

There are 18 200 km (11 300 miles) of operational BR line throughout Britain. A safety constraint limited the work to rural verges which cover 30 678 ± 1 121 ha. The Survey was structured to combine objective sampling, which would provide the information to classify and map the distribution of vegetation, with visits to sites of suspected biological interest. These latter were intended to ensure that a large proportion of areas of potential conservation value were described.

Originally the Survey was based on random sampling (Way *et al.* 1978). At that time,it was recognized that the distribution and representativeness of sampling could be improved by stratification (Lakhani this symposium), although information (such as soil pH or the slope or aspect of the verges) likely to reflect the distribution of vegetation was either not available or existed only at impractical scales. However, an alternative approach has been to use a multivariate classification of mapped (available) geographic attributes to structure a survey. Derived classes are used as strata, and samples are proportionately distributed between, and randomly selected within, these classes (Bunce *et al.* 1975). Land classifications at different scales and based on different assumptions are available for stratifying ecological survey (Bunce *et al.* and Ball *et al.* this symposium), but in all cases refer to cellular units of land. They could not be applied to the BR Survey as there is no constant relationship between the length of line crossing a cell and the area of land within that cell.

Because of this linear constraint, a new geographic classification, relating strictly to rural railway land, was made. This paper describes the BR classification and its application to survey, and discusses the value of the stratification method in terms of some field-collected data.

TABLE 1 Constant attributes of the 26 railway track classes distinguished by classification of 83 geographic attributes using Indicator Species Analysis. Only attributes occurring in at least 80% of track class members (10 mile units) are shown. The Table is ordered with an index derived from the first axis of a Reciprocal Average Ordination

	Southern Chalk Uplands	South Eastern	Chilters	South Coastal	Weald	South Midlands	Midlands & East Anglia	Northern Sandstones	Fens	Eastern Lowlands	Central Southern	South Western	West Coastal	Lancashire Plain	Pennine Coal Measures	Scottish Lowlands	Midland Hills	Pennines	Western Coal Measures	North West Coastal	North Coast Carboniferous	Welsh Uplands	Igneous Coastal	Central Highlands	Highland Coastal	West Highlands
<7.0C January	x	x			x																					
Well drained calc. soils	x							x																		
>6.0 hrs sun July	x	x	x	x	x				x		x	x														
Chalk and oolites	x									x																
<10 days snow cover		x		x							x	x	x	x												
Electrified		x	x														x									
<400' ASL	x				x	x									x				x							
<25' ASL				x					x																	
Alluvium		x			x								x													
Drift			x	x	x					x	x	x	x					x	x			x				
Stagnogleys					x	x	x								x	x					x					
<6.0 hrs sun July						x		x		x			x	x			x									
<20 days snow cover						x	x	x	x	x					x	x					x		x			
<100' ASL								x		x	x		x	x	x					x						
Salt marsh								x																		
Bunter														x		x										
Coal measures															x			x	x		x					
<200' ASL												x			x	x				x					x	
<30 days snow cover																		x								
<6.0C January									x	x						x								x		
Non-calc. brown earths											x	x	x				x			x		x				
<5.5 hrs sun July														x	x	x	x				x					
<6.5C January																	x	x								
Carboniferous & magnesian																	x				x					
Igneous & intrusive																					x					
<400' ASL																		x						x		
Boulder clay																		x	x	x			x		x	x
Lowland podzols																								x	x	
Heath/rough pasture																			x	x				x	x	x
Single track																						x	x		x	x
Metamorphic																										x
Upland gleys																										x

TRACK CLASSIFICATION AND SAMPLING

The rural railway network was divided into 899 measured 10 mile (16.1 km) units, coincident with BR ¼ mile posts. Selected mapped attributes were scored, where they abbutted on to, or were crossed by the railway line, for each of these units (Sargent & Mountford 1980). The information was classified using Indicator Species Analysis (Ball *et al.* this symposium; Hill *et al.* 1975), a polythetic divisive method based on correspondence analysis. After inspection and some modification, the classification yielded 26 track classes (ie groups of 10 mile units). Constant attributes, which are present in more than 80% of members of each track class, are shown in Table 1. The Table is ordered using an index derived from the relative representativeness of each attribute within each track class, and is designed to show relationship between classes. There is an evident gradient between lowland south eastern and upland north western classes. Some classes are more heterogeneous than others: for example, there are only 2 constant attributes in the large (70 units) class 'Midlands and East Anglia', whereas 'Pennine Coal Measures' (51 units) has 7 constant attributes, and the smaller class 'Weald' (28 units) has 6. The average number of 10 mile units per class is 36, and the mean number of attributes, 5.

A total of 480 sites was distributed proportionately between track classes. Units to be sampled were randomly selected, and 100 m sampling sites located at randomly chosen BR mile posts within the track class unit. For practical purposes, sites were restricted to areas of convenient access. Four transects were measured at each site at right angles to the track, the direction which, within a short stretch of line, usually includes most variation. A number of 2 x 2 m quadrats, strictly proportional to the width of the verge, were distributed along each transect. Species cover and height were recorded, and pH and certain other environmental measurements taken. Species lists for entire sites were made.

The track classification has been digitized and mapped by the Natural Environment Research Council's Experimental Cartography Unit, and, as an example, the distribution of track classes and sample sites in the London Midland Region is shown in Plate 1.

VEGETATION CLASSIFICATION

A synopsis of a working classification of railway grasslands and tall herb communities showing constant species (present in >80% of like samples) is given in Table 2. The minimum cover value recorded for each constant species in at least 75% of samples is also given. The cover values are from the following simplified scale:

<1	1
1-10	2
11-25	3
26-50	4
51-100	5

The classification is of information from a subset of 120 sites (937 samples) distributed proportionately within the 26 track classes. The classification method used was TWINSPAN (Hill 1979), a FORTRAN program based on correspondence analysis, which produces an ordered two way table by the grouping of both samples and species. After inspection, some modifications were made and the vegetation divided into 24 working classes, which will be tested against the entire data set. Scrub and secondary woodland classes have, for simplicity,

TABLE 2 Synopsis of a working classification by TWINSPAN of 937 railway grasslands and tall herb communities

	Upland bent/fescue	Grass heath	Bent/fescue	Coarse fescue	Neutral fescue	Ruderal/fescue	Calcicolous grassland	Heath false brome	Species rich false oat	Coarse false oat	False oat and bramble	Creeping soft grass	Meadowsweet	Nettle/false oat	Tall herb and bramble
No of samples	7	17	14	62	43	18	9	17	37	114	115	18	19	58	90
Agrostis tenuis	5	3	4												
Festuca rubra	2	1	4	3	4	3	3	2	2	2					
Galium saxatile	2														
Juncus effusus	2														
Arrhenatherum elatius				2	2			2	4	4	4	2	1	4	
Holcus lanatus				1											
Plantago lanceolata					1	2	1								
Dactylis glomerata				1	1			1		2					
Fragaria vesca							2								
Chrysanthemum leucanthemum							2								
Brachypodium pinnatum								5							
Rubus fruticosus											2				1
Holcus mollis												3			
Filipendula ulmaria													4		
Urtica dioica														2	4
Galium aparine														1	1

been pooled (their identification is not central to the discussion) and grasslands and tall herb communities occurring in fewer than 7 samples have been excluded from the synoptic table. Thus, for example, *Molinia* grasslands (close to the *Molinia-Myrica nodum* of McVean and Ratcliffe 1962) which were largely restricted to the West Highland line (Sargent & Mountford 1981) and common reed (*Phragmites australis)* beds, which occur on some embankment footings, are not included.

For convenience, in this paper, the working vegetation types have been given brief English names. Detailed phytosociological information will be published elsewhere.

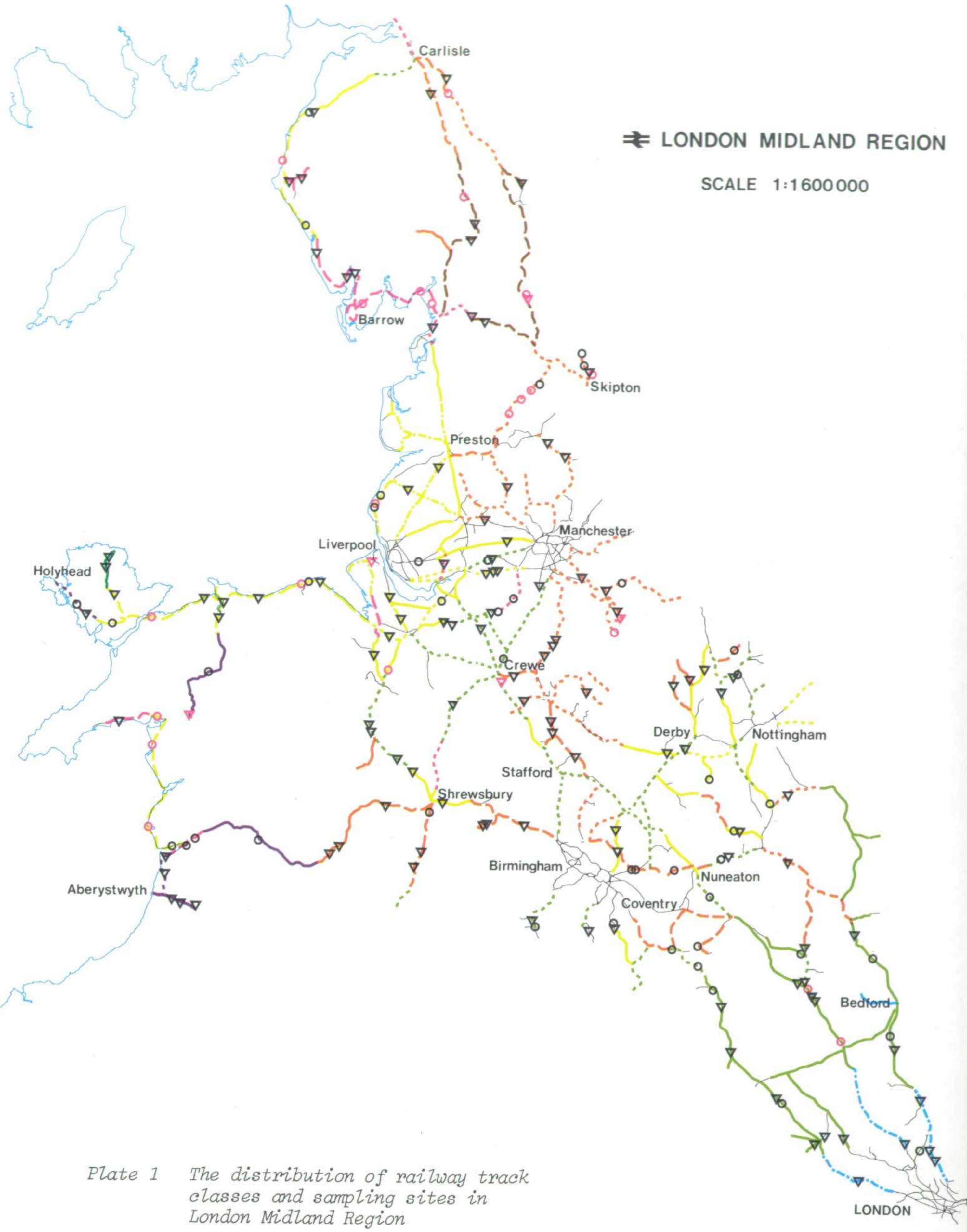

Plate 1 The distribution of railway track classes and sampling sites in London Midland Region

LEGEND

TRACK CLASSIFICATION

South Eastern

Weald

Southern Chalk Uplands

Chilterns

South Western

Central Southern

South Coastal

South Midlands

Midlands and East Anglia

Eastern Lowlands

Fens

Pennine Coal Measures

Northern Sandstones

West Coastal

Lancashire Plain

Pennines

Western Coal Measures

Midland Hills

North Coast Carboniferous

Scottish Lowlands

North West Coastal

Highland Coastal

West Highlands

Central Highlands

Welsh Uplands

Igneous Coastal

SAMPLING SITES

Random

Biological Interest

Cutting / Embankment

Random - revisited during 1981

SITES OF PARTICULAR BIOLOGICAL INTEREST

Random

Biological Interest

Cutting / Embankment

Random - revisited during 1981

Cartography by the Experimental Cartography Unit

THE DISTRIBUTION OF VEGETATION TYPES

Broadly, the classification distinguishes between vegetation which is dependent on the disturbed railway environment, and that which occurs, although comparatively uninfluenced, where the take of railway land is sufficiently great.

TABLE 3 Distribution of vegetation types within track classes

	Scottish Lowlands	South Western	Midlands & East Anglia	West Coastal	South Midlands	Pennines	Pennine Coal Measures	Southern Chalk Upland	Midland Hills	Northern Sandstones	Weald	North Coast Carboniferous	Chilterns	Central Southern	Central Highlands	Western Coal Measures	Eastern Lowlands	South Eastern	West Highlands	Igneous Coastal	Fens	Highland Coastal	Lancashire Plain	Welsh Uplands	South Coastal	North West Coastal	TOTAL
Tall herb and bramble	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	23
Coarse false oat	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x			x	x	x	x	x		x	22
False oat and bramble	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x		x	x		x				20
Coarse fescue	x	x	x	x	x	x	x		x	x	x				x	x	x			x		x		x		x	17
Nettle/false oat	x		x		x	x	x	x	x	x		x			x	x	x				x	x	x		x		16
Species rich false oat	x		x		x	x	x	x	x		x		x	x	x			x					x				13
Neutral fescue	x	x	x			x	x	x		x		x			x	x				x							11
Ruderal/fescue		x		x	x	x	x	x		x				x						x							9
Grass heath	x		x	x		x	x					x			x				x								8
Meadowsweet			x		x						x	x	x	x			x										7
Creeping soft grass	x		x	x			x				x				x	x											7
Bent/fescue	x					x	x			x		x							x					x			7
Heath false brome																		x			x						2
Calcicolous grassland								x																			1
Bramble, scrub and secondary woodland	4	9	3	6	4	2	1	4	5	3	3	2	4	3	1	3	1	3	4	1	1	3	1	2	4	2	79
No. types/class	14	14	13	13	12	12	12	11	11	11	10	10	9	9	9	9	7	7	7	7	6	6	6	6	6	5	242

Table 3 shows the distribution of vegetation types within track classes. The Table is ordered so that the most widespread vegetation (ie occurring in most track classes) and track class (ie including the largest numbers of vegetation types) are given respectively in the first row and column. There is no correlation between all track and vegetation classes, and there is no strong correlation ($r = 0.565$) between the verge area of each track class and the number of vegetation types present (Figure 1). However, a clear pattern exists within Table 3: vegetation associated with disturbance is widespread, whilst vegetation independent of railway influence has a more restricted distribution. Coarse false oat grassland occurs in 22 of the 26 track classes. The grassland shows a preference for embankment slopes where ballast has been tipped, but is generally abundant on ungrazed verges. False oat is not present in the 2 North West Scottish classes, where soil and climate conditions are extreme. It is also absent from the 'Southern Chalk Uplands', where herb rich fescue grasslands are predominant, and from 'South Eastern', where very little present management has been recorded and bramble has become ubiquitous. Absence from the latter 2 classes may be an artefact of the smallness of the subset of samples.

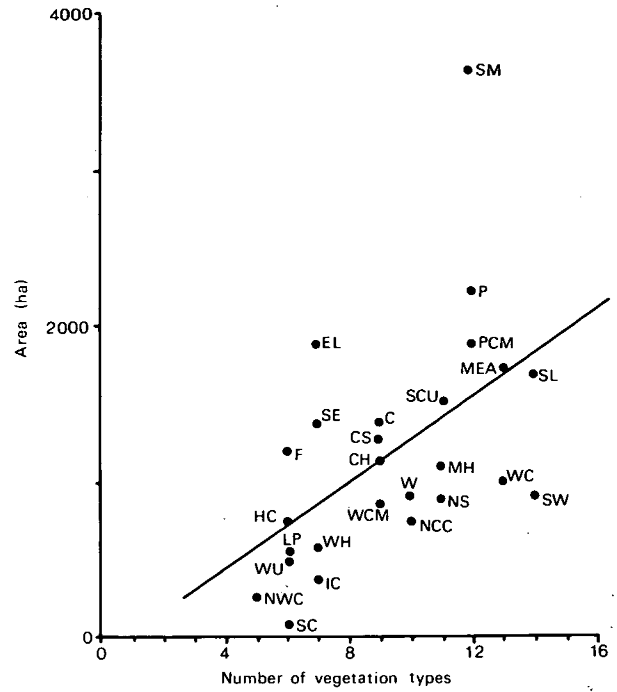

Figure 1 *The number of vegetation types per track class against track class area is shown. All vegetation types, including scrub and secondary woodland, are given. Track class names are abbreviated to initials:*

SCU Southern Chalk Uplands SE South Eastern C Chilterns SC South Coastal W Weald SM South Midlands MEA Midlands & East Anglia NS Northern Sandstones F Fens EL Eastern Lowlands CS Central Southern SW South Western WC West Coastal LP Lancashire Plain PCM Pennine Coal Measures SL Scottish Lowlands MH Midland Hills P Pennines WCM West Coastal Measures NWC North West Coastal NCC North Coast Carboniferous WU Welsh Uplands IC Igneous Coastal CH Central Highlands HC Highland Coastal WH West Highlands

Bent/fescue grassland, on the other hand, is found in only 7 of the track classes; these all occur in upland north and west Britain. Heath false brome grassland, on railway verges, is virtually restricted to calcareous cuttings in Eastern Region, and the herb rich fescue grassland, called here, loosely, 'Calcicolous', is recorded only from unstable chalk slopes in the class 'Southern Chalk Uplands'.

Ideally, a stratification of railway land would accommodate such widely differing distributions. However, there are several factors which deflect the establishment and development of vegetation which might otherwise be expected to occur locally. In particular, edge effects along this linear environment are important. These arise both from track maintenance and from adjacent land usage.

Vegetation within 3-4 m of the track and growing on embankment slopes tends to be disturbed by chemical spraying, cutting, waste disposal from trains and the cyclical dumping of spent, often oily, ballast. Along main lines, ballast is replaced about every 5 years. False oat grass, which is known as a primary colonizer of limestone screes in Derbyshire (Pfitzenmeyer 1962), tends to spread rapidly on to spent ballast, which also provides a habitat for such characteristic railway plants as Oxford ragwort (*Senecio squalidus*), small toadflax (*Chaenorhinum minus*) and spear leaved willow herb (*Epilobium lanceolatum*) which is now found to be increasing its range. Particularly where there is nearby woodland, bramble spreads on to such tips, whilst some ephemerals and annuals, including lamb's lettuce (*Valerianella locusta*) and stinking groundsel (*Senecio viscosus*), grow where the spent material is fine grained or cindery. Other plants, such as the common horsetail (*Equisetum arvense*) and the bonfire site moss (*Funaria hygrometrica*) show resistance to the chemical sprays in use, or, as spring whitlow grass (*Erophila verna*), avoid disturbance by completing their life cycles before spraying occurs in early summer. This kind of influence from track maintenance is ubiquitous along cess margins, and produces a vegetation which is similar throughout BR land.

Effects from adjacent land usage are clearly more diverse, and include such variables as agricultural spray drift, the grazing of a marginal strip in pastoral land, dumping of garden rubbish and propagules, and seeding and shading from coniferous plantations. Where these edge effects (cess and boundary) are small compared with the width of the railway verge, the vegetation is usually modified by previous management practices. Since 1960, however, only sporadic or *ad hoc* clearance of the verges has occurred. Whilst the general approach to maintenance, prior to this date, is well known - verges were scythed and burnt once or twice annually, and most invasive scrub cut and cleared - there are no areas for which a documented and continuous record of the work done exists.

A very important influence on the distribution of vegetation is the slope angle and kind (embankment, cutting, flat) of formation. Slope and angle clearly affect drainage, insolation and exposure, whilst the kind of formation may determine the quality of the soil. Embankments were built from available materials, and often topsoiled, whilst cuttings were merely excavated. Fine leaved and species rich grasslands, and scrub and secondary woodland, characteristic of local soil or climatic conditions, are usually found on cutting slopes. These tend to have a low soil nutrient status and are comparatively uninfluenced by track management. The fine leaved grasslands were maintained by cutting and burning, and it is probable that many are now being replaced by woody species. This kind of information was not available prior to field sampling, and it is clear that the man-made and disturbed linear railway environment is, to some extent, independent of the local soil and climatic conditions reflected in the stratification. This independence is confirmed by the lack of correlation between vegetation and track classes (Table 3), despite the distribution preferences shown by some vegetation types. The stratification can be amplified with field-collected data, although its predictive value remains limited because there is so much, and such variable, disturbance.

Nevertheless, use of multivariate classes to stratify the system has ensured a good distribution of samples, and has given rise to smaller and comparatively homogeneous units, amenable to analysis, interpretation and discussion. It has also provided a framework for looking at the potential value of BR land in terms of management for conservation purposes.

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